1995

LAKE AND WETLAND MONITORING PROGRAM REPORT/SUMMARY

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Summary

The Kansas Department of Health and Environment (KDHE) Lake and Wetland Monitoring Program surveyed the water quality conditions of 34 Kansas lakes and wetlands during 1995. Eight of these lakes were federal reservoirs, two were major wetlands, and the remaining 24 represented State Fishing Lakes (SFLs)/State Parks, city/county lakes, and publicly owned lakes in special areas of the state. Three of these lakes and wetlands were visited, but not sampled, due to dewatered conditions. Gridley City Lake was found to have been drained, Brown County SFL was drawn down for fishery management, and Texas Lake wetland was too low to accommodate sample collection.

Most of the surveyed lakes appeared to be constant-to-degrading, as compared to their last surveys, with regard to their assigned trophic state. Eleven lakes indicated reasonably constant trophic states since their last surveys, while 12 indicated an increased trophic state. Seven lakes were surveyed in 1995 that indicated an improvement in trophic state since their last water quality survey. One waterbody was new to the Lake and Wetland Monitoring Program and, therefore, had no past data for assessing trends.

A total of 78 exceedences of the Kansas numeric water quality criteria, or Environmental Protection Agency (EPA) water quality guidelines, were documented in the surface waters of the 31 surveyed lakes. Thirty-two of these exceedences concerned aquatic life support criteria. Forty-six concerned water supply, human health (food procurement use), livestock watering, or irrigation criteria.

Atrazine was the most often detected pesticide in Kansas lakes during 1995. Fourteen lakes had detectable concentrations of atrazine within their main bodies. These detections ranged in concentration from 0.31 to 5.50 ug/L. Dual was detected in three lakes (concentration ranging from 0.47 to 1.80 ug/L), while alachlor and simazine were detected in one lake each (0.55 and 2.0 ug/L, respectively). Three of the 14 lakes with detectable atrazine levels exceeded applicable aquatic life support numeric criteria in the Kansas Surface Water Quality Standards (1.0 ug/L = chronic aquatic life support criterion). Only one of the 14 lakes exceeded the EPA Maximum Contaminant Level (MCL) for atrazine in drinking water (3.0 ug/L).

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INTRODUCTION

Development of the Lake and Wetland Monitoring Program

The Kansas Department of Health and Environment (KDHE) Lake and Wetland Monitoring Program was established in 1975 to fulfill the requirements of the 1972 Clean Water Act (Public Law 92-500) by providing Kansas with background water quality data for water supply and recreational impoundments, by determining regional and time trends for those impoundments, and by identifying pollution control and/or assessment needs within individual lake watersheds.

Program activities originally centered around a small sampling network comprised mostly of federal lakes, with sample stations at numerous locations within each lake. In 1985, based on the results of statistical analyses, the number of stations per lake were reduced to a single station within the main body of each impoundment. This, and the elimination of parameters with limited interpretive value, allowed expansion of the lake network to its present 117 sites scattered throughout all the major drainage basins and physiographic regions of Kansas. The program remains dynamic, with lakes occasionally being dropped from active monitoring and/or replaced with more appropriate sites throughout the state.

In 1989, KDHE initiated a Taste and Odor/Algae Bloom Technical Assistance Program for public drinking water supply lakes. This was done to assist water suppliers in identifying and controlling taste and odor problems, in finished drinking water, that result from lake ecological processes and algae blooms.

Overview of the 1995 Monitoring Activities

Staff of the KDHE Lake and Wetland Monitoring Program visited 34 Kansas lakes during 1995. Three of these lakes were found to be dewatered. Of the 31 surveyed sites, eight are large federal lakes last sampled in 1992, nine are State Fishing Lakes (SFLs)/State Parks/Game Management Areas, seven are city/county lakes (CLs and Co. lakes, respectively), one is a major wetland/wildlife management areas (WMAs), four are lakes within the Mined Land Lakes Area in extreme southeast Kansas, and two are small lakes in the Cimarron National Grasslands in extreme southwest Kansas. Ten of the 31 surveyed lakes serve as either primary or back-up public water supplies (PWSs). In addition to these routine monitoring activities, staff were involved in a study of seven small lakes in northeast Kansas, investigating the impacts of small point source dischargers on lakes. This study was partially funded by an EPA mini-grant for Total Maximum Daily Load (TMDL) development.

Table 1 compiles some general information on the lakes surveyed during 1995. Figure 1 presents the locations of the 34 lakes and

Table 1. General Information Pertaining to Lakes Surveyed in 1995.

Lake	Basin	Authority	PWS(*)	Last Surveyed
Big Hill Lake	VE	FMPR	*	1992
Centralia Lake	KR	Local		new
Clark Co. SFL	CI	State	*	1990
Concannon SFL	UA	State		1990
Elk City Lake	VE	FMPR	*	1992
Fall River Lake	VE	FMPR	*	1992
Goodman SFL	UA	State		1989
Herington Reservoir	SS	Local	*	1994
Jamestown WMA	KR	SWWA		1992
Jetmore Lake	UA	Local		new
Jewell Co. SFL	SO	State		1989
Kirwin Lake	SO	FMPR		1992
Lake Coldwater	CI	Local		1990
Lake Kahola	NE	Local	*	1990
Lake Meade SP	CI	·State		1989
Lake Scott SP	SS	State		1989
Lake Shawnee	KR	Local		1990
Lovewell Lake	KR	FMPR		1992
Mined Land Lake 6	NE	State		1991
Mined Land Lake 7	NE	State		1990
Mined Land Lake 17	NE	State		1991
Mined Land Lake 44	NE	State	Faw F L NE	1990
Moss Lake (central)	CI	Federal		1992
Moss Lake (west)	CI	Federal		1992
Norton Lake	UR	FMPR	*	1992
Otis Creek Lake	VE	Local	*	new
Ottawa Co. SFL	so	State		1989
Rooks Co. SFL	so	State	- Merchanis	1989
Toronto Lake	VE	FMPR	10 a * 10 a 10 a 10 a 10 a 10 a 10 a 10	1992
Waconda Lake	so	FMPR	* *	1992
Washington Co. SFL	KR	State		1989

1	C1	_	CIM	arr	ron

KR = Kansas/Lower Republican

LA = Lower Arkansas

MC = Marais des Cygnes

MO = Missouri

NE = Neosho

SO = Solomon

SS = Smoky Hill/Saline

UA = Upper Arkansas

UR = Upper Republican

VE = Verdigris

WA = Walnut

FMPR = Federal Multipurpose

Reservoir

WMA = Wildlife/Game

Management Area

SFL = State Fishing Lake

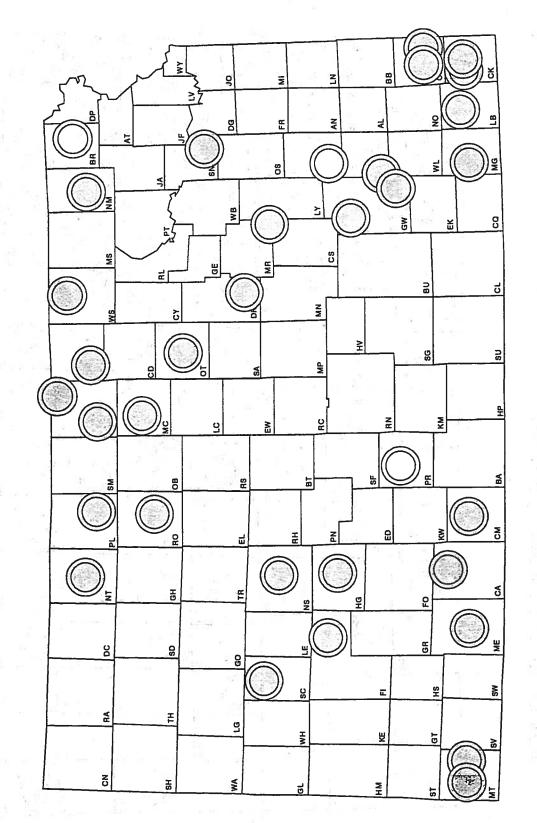
SWWA = State Wetland/

Wildlife Area

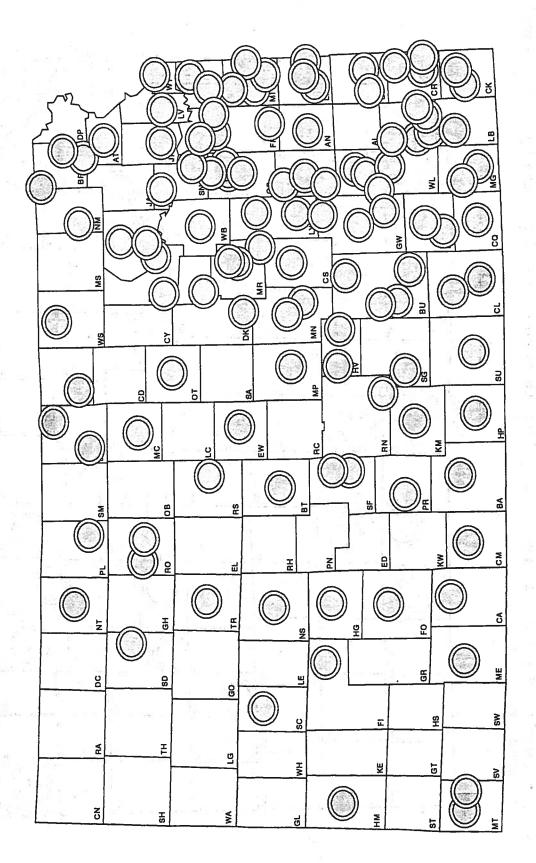
FWWA = Federal Wetland/

Wildlife Area

and Monitoring Program. The 31 sites sampled are indicated by dark The three sites that could not be sampled are identified by light colored the 34 lake and wetland sites visited during 1995 by the KDHE Lake and Wetland Monitoring Program. Locations of symbols. symbols. Figure



currently active lake and wetland sampling sites within the KDHE Locations of all currently active lak Lake and Wetland Monitoring Program. Figure 2.



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wetlands visited during 1995. Figure 2 presents the locations of all currently active sites within the Lake and Wetland Monitoring Program. In addition to routine lake monitoring, six public lakes and private ponds were investigated as part of the Taste and Odor/Algae Bloom Technical Assistance Program.

Created lakes are usually termed "reservoirs" or "impoundments," depending on whether they are used for drinking water supply or for other beneficial uses, respectively. In many parts of the country, smaller lakes are termed "ponds" based on arbitrary surface area criteria. To provide consistency, this report uses the term "lake" to define all non-wetland bodies of standing water within the state. The only exception to this is when more than one lake goes under the same general name. For example, the city of Herington, Kansas, has jurisdiction over two lakes. The older lake is called Herington City Lake while the newer lake is called Herington Reservoir in order to distinguish it from its sister waterbody.

METHODS

Yearly Selection of Monitored Sites

Since 1985, the 24 large federal lakes in Kansas have been arbitrarily partitioned into three groups of eight. Each group is sampled once during a three year period of rotation. Up to 30 smaller lakes are sampled each year in addition to that year's block of eight federal lakes. These smaller lakes are chosen based on three considerations: (1) Is there recent data available (within the last 3-4 years)?; (2) Is the lake showing indications of pollution that require enhanced monitoring?; or (3) Have there been water quality assessment requests from other administrative or regulatory agencies (state, local, or federal)? Several lakes have been added to the network due to their relatively unimpacted watersheds. These lakes serve as "ecoregional" reference sites.

Sampling Procedures

At each lake, a boat is anchored over the inundated stream channel near the dam. This point is station 1 for each lake, and should represent the area of maximum depth. Duplicate water samples are taken by Kemmerer sample bottle at 0.5 meters below the surface for determination of inorganic chemistry (basic anions and cations), algal community composition, chlorophyll-a, nutrients (ammonia, nitrate, Kjeldahl nitrogen, and phosphorus), and metals (aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc). Duplicate water samples are also taken at 0.5-to-1.0 meters above the lake substrate for the determination of inorganic chemistry, nutrients, and metals within the hypolimnion. In addition, a single pesticide sample is taken at 0.5 meters and duplicate surface bacterial

samples (fecal coliform and fecal streptococci) are taken at either the public swimming area or main boat ramp/courtesy dock/fish cleaning station area (KDHE, 1995).

Beginning with the 1992 sampling year, macrophyte surveys have been conducted at each of the smaller lakes (<300 acres) within the KDHE Lake and Wetland Monitoring Program sampling network. The survey consists of the selection of 10-20 sampling points, plotted on a field map in a regular pattern over the lake surface. At each sampling point, the boat is stopped and a grappling hook cast to rake the bottom for submersed aquatic plants. This, combined with visual observations at each station, determines presence or absence of macrophytes at the station. If present, macrophyte species are identified and recorded on site. Those species that can't be identified in the field are placed in plastic bags, on ice, for identification at the KDHE Topeka office. Presence/absence data, and species specific presence/absence data, are used to calculate a "percent distribution" estimate for each lake (KDHE, 1995).

At each lake, measurements are made at station 1 for temperature and dissolved oxygen profiles, field pH, and Secchi disk depth. All samples are preserved and stored in the field in accordance with KDHE Quality Assurance/Quality Control protocols (KDHE, 1995). Field measurements, chlorophyll analysis, and algal taxonomy are conducted by staff of KDHE's Office of Science and Support. All other analyses are carried out by the KDHE Health and Environmental Laboratory (KDHE, 1995).

Taste and Odor/Algae Bloom Program

In 1989, KDHE initiated a formal Taste and Odor/Algae Bloom Technical Assistance Program. Technical assistance concerning taste and odor incidences in water supply lakes, or algae blooms in lakes and ponds, may take on varied form. Investigations may simply involve identification of algal species present within a lake, or they may entail the measurement of numerous physical, chemical, or biological parameters including watershed land use analysis to identify nonpoint pollution sources. Investigations are generally initiated at the request of treatment plant personnel, local authorities, or personnel at any KDHE District Office. While lakes used as public water supplies are the primary focus, a wide variety of samples related to algae, odors, and fishkills, from both streams and lakes, are accepted for analysis.

RESULTS AND DISCUSSION

Lake Trophic State

Calculation of the Carlson Chlorophyll-a Trophic State Index (TSI) remains a useful tool for comparison of lakes in regard to general ecological functioning and level of productivity (Carlson, 1977).

Table 2 presents TSI scores for the 1995 lakes, previous TSI scores for lakes with past data, and an indication of the extent that individual lakes were dominated by submersed and floating-leaved vascular plant communities (macrophytes). Since chlorophyll TSI scores are based on the planktonic algal community, a dominance by macrophytes "bumped" the trophic state classification to the next highest level than that assigned by TSI score alone. The system used to assign trophic state, based on the TSI score, is given below. It represents an in-house modification of the Carlson TSI system to account for macrophytic productivity. Trophic state classification is adjusted for macrophytes where percent areal cover (as estimated by percent presence) is estimated at 30% or greater.

TSI score of 0-39 = Oligo-Mesotrophic = O/M.

O/M = A lake with a low level of planktonic algae and no significant macrophyte community. In a number of Kansas lakes, this condition is related to high turbidity. In such cases, nutrient availability remains high, but is not translated into biological productivity or biomass due to light limitation. Lakes with such high turbidity and nutrient levels, but such low algal production, may be called "argillotrophic" (Naumann, 1929) rather than oligo-mesotrophic. The argillotrophic class is identified by the letter "A" within this report.

TSI score of 40-49 = Mesotrophic = M.

M = A lake with only a moderate planktonic algal community, or a small algal community combined with a significant macrophyte community.

TSI score of 50-63 = Eutrophic = E.

E = A lake with a large planktonic algal community or a moderate algal community combined with a significant macrophyte community. This category is further divided as follows:

TSI = 50-54 = slightly eutrophic = SE,

TSI = 55-59 = fully eutrophic = E,

TSI = 60-63 = very eutrophic = VE.

TSI score of 64 or greater = Hypereutrophic = H.

H = A lake with a very large planktonic algal community or a large algal community combined with a significant macrophyte community.

All Carlson chlorophyll TSI scores are calculated by the following formula, where C is the phaeophytin corrected chlorophyll- \underline{a} level in ug/L (Carlson, 1977):

$$TSI = 10(6-(2.04-0.68ln(C))/ln2).$$

The composition of the algal community often gives a better ecological picture of a lake than relying solely on a trophic state classification. Table 3 presents both total algal cell count and percent composition of several major algal groups for the lakes surveyed in 1995. Lakes in Kansas that are nutrient enriched tend to be dominated by green or blue-green species, while those dominated by diatom communities may not be so enriched. Certain species of blue-green, diatom, or dinoflagellate algae may contribute to taste and odor problems, when present in large numbers, in lakes or streams that serve as public drinking water sources.

Trends in Trophic State

Trends in trophic state, among the 31 surveyed lakes, appeared to be stable-to-degrading since the last surveys. Table 4 presents the results of the comparison of current trophic state to past records.

Of the 31 lakes surveyed in 1995, twelve lakes displayed increases in lake trophic state (about 40%). Eleven lakes remained stable over time (about 38%). Only about 22% of the lakes surveyed in 1995 show improvement (lower trophic state) since their last surveys.

As can be seen in Table 5, eight of the 17 macrophyte surveys resulted in no macrophytes being found. This may mean that cover was non-existent, or it may merely indicate that macrophyte presence was so sparse as to preclude detection using the current technique. In the nine lakes with measurable macrophyte communities, the common plant species were various forms of pondweed (Potamogeton spp.), parrot feather (Myriophyllum sp.), coontail (Ceratophyllum demersum), and stonewort algae (Charaspp.).

Lake Stratification

Stratification is a natural process that occurs in any standing body of water, whether that waterbody is a natural lake, pond, artificial reservoir, or wetland pool (Wetzel, 1983). It occurs when sunlight (heat energy) penetrates into the water column. Due to the thermal properties of water, high levels of sunlight (combined with calm winds during the spring-to-summer months) cause layers of water to form with differing temperatures. The cooler layer (hypolimnion) remains near the bottom of the lake while the

Table 2. Current and past TSI scores, and trophic state classifications for the 1995 lakes. The abbreviations used previously for trophic state levels (O/M, M, E, H) apply here. An asterisk appearing after the name of a lake denotes that the lake was macrophyte dominated. In such a case, the trophic state based solely on TSI score is given, followed by the macrophyte-adjusted TSI score in parentheses.

Lake 1	1995 TSI &	Status	Previous Status
Big Hill Lake	47.5	M	SE
Centralia Lake	73.3	H	- M
Clark Co. SFL*	53.0	SE(E)	M
Concannon SFL	68.0	H	E " (1)
Elk City Lake	60.4		M
Fall River Lake	54.9	SE	M and the second
Goodman SFL	58.8		M
Herington Reservoir	52.9	SE	VE
Jamestown WMA	78.0	H	H de a e
Jetmore Lake*	41.1	M(SE)	SE
Jewell Co. SFL	53.7	SE	H
Kirwin Lake	63.4	VE	VE
Lake Coldwater	68.3	H	VE
Lake Kahola	49.9	M	M
Lake Meade SP*	58.2	E(VE)	n ng n H ng s ^{sa} an
Lake Scott SP*	63.3		H
Lake Shawnee	56.7		E
Lovewell Lake	56.3		VE
Mined land Lake 6	51.1	SE	SE
Mined Land Lake 7*	36.4	M(SE)	M
Mined Land Lake 17	41.9	M	M
Mined Land Lake 44	55.2	\mathbf{E}	M
Moss Lake (central)	59.5	E	E
Moss Lake (west) *	47.4	M(SE)	SE
Norton Lake	46.7	M	E
Otis Creek Lake	48.2	M	unknown
Ottawa Co. SFL*	58.1	E(VE)	H = 1
Rooks Co. SFL*	67.4		a E , ga
Toronto Lake	56.7	E	M M M
Waconda Lake	68.0	H	SE
Washington Co. SFL*	45.1	M(SE)	SE

Table 3. Algal communities present in the 1995 lakes at the time of sampling. The value in the count column is in cells/uL. "Other", in the far right column, refers to euglenoids, cryptophytes, dinoflagellates, and other single-celled flagellates. A "*" next to a number indicates that the percent of total, based on a biomass consideration, would be significantly above the percent of total shown, which is based on cell numbers.

Lake	Total Count	A 17	Percent Comp	osition	
	cells/uL)	green	bluegreen	diatoms	other
Big Hill Lake	12.66	17	77	5	*1
Centralia Lake	255.78	<1	>99	0	0
Clark Co. SFL	11.15	87	0	*5	*7
Concannon SFL	169.16	1	43	56	0
Elk City Lake	6.17	55	0 0 2	26	*19
Fall River Lake	2.71	72	e 6 0	*23	*5
Goodman SFL	19.22	8	0	92	0
Herington Res.	6.99	32	54	10	4
Jamestown WMA	61.74	4	0	90	6
Jetmore Lake	6.30	88	U 0 0	8	4
Jewell Co. SFL	3.15	38	0	28	*34
Kirwin Lake	33.96	41	13	*27	19
Lake Coldwater	56.95	10	75	14	1
Lake Kahola	2.90	50	0	20	*30
Lake Meade SP	17.14	94	0	5	*1
Lake Scott SP	20.79	33	44	*23	<1
Lake Shawnee	63.50	2	96	0	2
Lovewell Lake	11.03	45	4 o 0	43	12
Mined Land Lake 6	5.42	44	0	3	53
Mined Land Lake 7	3.53	46	0	21	33
Mined Land Lake 17	1.32	48	0	19	*33
Mined Land lake 44	12.22	45	0	17	*38
Moss Lake (cent.)	48.20	73	0	24	*3
Moss Lake (west)	16.63	54	15	11 4	*20
Norton Lake	5.10	58	0	17	*25
Otis Creek Lake	8.88	21	35	41	3
Ottawa Co. SFL	7.06	54	· 0	14	*32
Rooks Co. SFL	45.23	35	15	11	*39
Toronto Lake	3.65	41	9	45	*5
Waconda Lake	22.81	56	- I - C - I - O - I	1 10 10 3	*41
Washington Co. SFI	2.33	22	0	49	*29

upper layer (epilimnion) develops a higher ambient temperature. The middle layer (metalimnion) displays a marked drop in temperature with depth (the thermocline), compared to conditions within the epilimnion and hypolimnion.

Once these layers of water with differing temperatures form, they tend to remain stable and do not easily mix with one another. The net result is no re-oxygenation from the atmosphere within the hypolimnion, at least for the duration of the summer (or until ambient conditions force mixing). In many cases, this causes hypolimnetic waters to be depleted of oxygen and unavailable for fish and other aquatic life as habitat. Stratification eventually breaks down in the fall when surface waters cool. Once epilimnetic waters cool to temperatures comparable to hypolimnetic waters, the lake will mix completely once again. The fall time of lake mixing is called "lake turnover."

Table 4. Trends over time for lake trophic state classification within each major river basin in Kansas. One of the 31 surveyed lakes was new to the program. Therefore, the trend for this lake is unknown.

Basin		Constant		er of Lakes	Degrading	15 de
Cimar	ron	2	o Y	1	2	
Kansa	s/Lower	"District of the				
Repul	olican	3 3		1	100	
Neosh		3		0	2	
Smoky	Hill/Sali	ne 1		1 -	0	
Solomo		100 1		2	2	
Upper	Arkansas	1	all B	0	2	
	Republica	in 0		1 - 2	9 0 0 0	
Verdi		0		1	3	¥.
Totals		11	× ,_ =	7	12	

Lake turnover can cause fishkills, aesthetic problems, and taste and odor problems in drinking water if the hypolimnion comprises a significant volume of the lake. This is because such a sudden mixing combines oxygen-poor, nutrient-rich hypolimnetic waters with epilimnetic waters that are lower in nutrients and richer in dissolved oxygen. This often results in explosive algae growth, lowering of overall lake dissolved oxygen levels, sudden fishkills, and often imparts objectionable odors to the lake water and tastes or odors to drinking water produced from the lake. Therefore, this lake process is important in lake management, the ability of the waterbody to support aquatic life, and the ability of the waterbody to support sport fisheries.

Table 5. Macrophyte community structure in 17 of the lakes surveyed during 1995. Macrophyte community in these surveys refers to submersed and floating-leaved aquatic plants, but not to the emergent shoreline community. The percent species cover is the abundance estimate for each documented species (Note: due to overlap in species cover, the percentages under community composition may not equal the percent total cover.).

Lake	% Total Cover			pecies Cover and munity Composition
Clark Co. SFL	45%	2	45%	
THE PROPERTY OF THE PARTY OF			45%	<u>Ceratophyllum</u> <u>demersum</u>
			45%	Potamogeton pectinatus
			5%	Potamogeton crispus
Concannon SFL	<10%		<10%	none
Goodman SFL	<10%		<10%	none
Jetmore Lake	100%		100%	Najas guadalupensis
the set of			80%	Potamogeton foliosus
A HAS DESCRIPTION OF THE PARTY			60%	Chara sp.
Jewell Co. SFL	<10%		<10%	none
Lake Coldwater	<5%		<5%	none
Lake Kahola	<5%		<5%	none
Lake Meade	60%		60%	Chara globularis
			50%	Potamogeton pectinatus
= %, %, =			40%	Myriophyllum spicatum
			10%	Potamogeton nodosus
Lake Scott	87%		87%	Myriophyllum spicatum
			87%	Ceratophyllum demersum
Mined Land Lake 44	<6%		<6%	none
Mined Land Lake 7	50%		50%	Potamogeton pectinatus
1 5 - 1			50%	Potamogeton foliosus
Moss Lake (cent.)	<10%		<10%	none
Moss Lake (west)	100%		100%	Chara spp.
Otis Creek Lake	?%		?%	not sampled, but very low
Ottawa Co. SFL	100%		100%	Potamogeton nodosus
			100%	Ceratophyllum demersum
			100%	Myriophyllum spicatum
			100%	Lemna spp.
Bursh to Tale I have twice			70%	
Rooks Co. SFL	70%		70%	Ceratophyllum demersum
Washington Co. SFL	70%		70%	
			40%	Potamogeton nodosus

Presence or absence of stratification is determined by the depth profiles taken in each lake for temperature and dissolved oxygen concentration. Table 6 presents this data. Any temperature change greater than -1.0 degree Celsius per meter depth is considered evidence of strong thermal stratification (Hutchinson, 1957;

Wetzel, 1983), although temperature changes may be less pronounced during the initiation phase of stratification. Presence of a significant oxycline is also used to determine stratification. Many of the larger lakes, created by impounding major Kansas streams, exhibit "polymictic" behavior. In these lakes, stratification may never be very strong, and the water column may stratify and de-stratify several times during the summer.

Contact Recreation and Fecal Coliform Bacterial Counts

Beginning in 1992, the Lake and Wetland Monitoring Program discontinued collecting bacterial samples from the open waters of network lakes. Past data strongly indicated that fecal coliform counts are very low in the open water of Kansas lakes. condition is likely due to predation by protozoan organisms and the fact that limnetic environments are hostile to the survival of gut bacteria in general. In preference to open water samples, fecal bacteria counts are now made from either the main swimming beach (if a swimming beach exists it is first priority) or the main boat ramp area (if there is no swimming beach, this is the site of secondary priority). The selection of the boat ramp area as an alternate sampling site was made since it is one of the most likely sites for contact recreation, whether or not facilities exist for swimming. On occasion, samples near fish cleaning stations (third priority for sampling) may be taken for comparative purposes with past data from cleaning stations, if no swimming beaches exist.

Table 7 presents the bacterial data collected during the 1995 sampling season. All counts are compared to the 200 colonies/100 mL standard for contact recreation within the Kansas Surface Water Quality Standards (KDHE, 1994).

Three lakes, out of the 31 surveyed, had fecal coliform bacterial counts that exceeded the 200 colonies/100 mL criteria for contact recreation (average of duplicate samples). These three locations were the swimming beach at Big Hill Lake, Jamestown WMA, and Moss Lake (central) in the Cimarron National Grasslands.

Jamestown WMA might be expected to have higher bacterial counts due to its fairly extensive agricultural drainage and its shallow, wetland status. The lake within the Cimarron National Grasslands is small and shallow, and may be frequented by grazing animals. Field staff did observe people training their dogs to swim and fetch in this lake while it was being sampled.

The swimming beach at Big Hill Lake has come under scrutiny in the past for high fecal coliform bacterial counts. In the past, no adequate explanation could ever be identified for the high counts and data tended to be highly variable. This was the case during 1995 as well. The duplicate samples were highly variable, as can be seen in Table 7.

Lake and wetland stratification status for the 31 sites surveyed during 1995. Table 6.

I DI M DI									Ь		П									N .				
Maximum Depth Recorded (meters)	12.5	8.5	12.0	3.0	8.0	7.5	2.5	8.5	<2.0	4.0	7.0	5.0	6.5	10.0	2.0	4.0	12.5	0.6	3.5	0.6	15.0	13.5	<2.0	<2.0
Oxygen Thermocline Rate Depth meter) (meters)	4-7	4-5	5-7	none present	weak at 4	4 - 5	none present	none present	na	none present	4-5	na	3-4	9-2	none present	none present	4-7	na	2 to bottom	2-4	51 - 8	5-7	na	na
Dissolved Decline (mg/L per	-0.38	-0.69	-0.73	-0.38	-0.50	-0.83	•	-0.57	na	00.00	-1.14	na	-1.75	-0.58	-0.27	-0.05	-0.41	na	-2.63	96.0-	-0.59	-0.69	na	na
Temperature Decline Rate (degrees/meter)	-1.16	-1.13	-0.83	00.00	-0.33	-0.50	0.	-0.24	na	00.0	-1.29	na	-1.00	-1.10	•	00.0	-1.08	na	-1.00	-1.22	-0.87	-0.82	na	na
Date Sampled	July 31	July 24	July 10	June 21	July 31	July 31	June 21	August 21	June 26	June 20	June 26	June 6	July 10	August 7	July 11	June 21	July 18	June 5	6 May 31	7 May 30	17 May 30	44 May 30) July 11	
Lake	Big Hill Lake	Centralia Lake	Clark Co. SFL	Concannon SFL	Elk City Lake	Fall River Lake	Goodman SFL	Herington Res.	Jamestown WMA	Jetmore Lake	Jewell Co. SFL	Kirwin Lake	Lake Coldwater	Lake Kahola	Lake Meade SP	Lake Scott SP	Lake Shawnee	Lovewell Lake	Mined Land Lake	Land	Mined Land Lake	Mined Land Lake	Moss Lake (cent.	Moss Lake (west)

Lake and wetland stratification status for the 31 sites surveyed during 1995. Table 6 continued.

Lake	Date Sampled	Temperature Decline Rate (degrees/meter)	Dissolved Oxygen Decline Rate (mg/L per meter)	Thermocline Depth (meters)	Maximum Depth Recorded (meters)
Norton Lake Otis Creek Lake Ottawa Co. SFL Rooks Co. SFL Toronto Lake Waconda Lake	June 6 July 17 June 27 June 21 July 31 June 6 June 26	na na -0.17* -0.33 -0.50 na	na na -1.14* -0.27 -1.14 na	na na none present none present 3 to bottom na none present	3.5 3.5 3.5 3.0 5.5 11.5

data being taken below macrophyte = No thermal stratification, oxycline results from canopy.

Limiting Nutrients and Physical Parameters

The determination of which nutrient, or physical characteristic, "limits" phytoplankton production is of primary importance in lake management. If certain features can be identified, which exert exceptional influence on lake water quality, those features can be addressed in lake protection plans to a greater degree than less important factors. In this way, lake management can be made more efficient.

The concept of limiting nutrients, or limiting factors, is often difficult for the layman to grasp. The following analogy is provided in an attempt to clarify the concept:

A person is given 10 spoons, 9 knives, and 5 forks. They are then asked to place sets of utensils at each place at a table. Further, only complete sets of utensils are to be placed, with a complete set including all three utensils. The question is, "What utensil is the limiting factor?"

In this example, the number of forks available "limits" the number of place settings that can be made. Therefore, forks become the limiting factor for this scenario.

In a lake ecosystem, the level of algal production is the "place setting," while plant nutrients and light availability are the "spoons, forks, etc." Common factors that limit algal production in lakes are the levels of available nutrients (primarily phosphorus and nitrogen) and the amount of light available to power photosynthesis. Less common limiting factors in lakes include available levels of carbon, iron, temperature, and vitamins.

The use of nutrient ratios are commonly employed to estimate which major plant nutrients are limiting factors in lakes. These ratios take into account the relative needs of algae cells for the different chemical nutrients. Typically, total nitrogen/total phosphorus (TN/TP) mass ratios that are above 12 indicate phosphorus limitation. Conversely, TN/TP ratios below 7 indicate nitrogen limitation. Ratio numbers of 7-to-12 indicate that both, or neither, of these major plant nutrients may be limiting to phytoplankton production (Wetzel, 1983). The 1992 season marked the first during which total nitrogen data was available to the Lake and Wetland Monitoring Program, thus making the determination of limiting nutrients possible.

Table 8 presents limiting factor determinations for the lakes surveyed during 1995. It should be kept in mind that these determinations reflect the time of sampling (which is chosen to reflect "average" conditions during the summer months) but may not apply to other times of the year. Also, the assumption was made

Table 7. Fecal coliform bacterial counts (duplicate samples) from the 31 lakes and wetlands surveyed during 1995. Since wetlands are not considered "attainable" for contact recreational use, those values are given for informational purposes only. It should also be kept in mind that these are one time grab samples taken during the week, not during the weekends which should be higher use periods. All units are in "number of colonies per 100 mL of lake water."

- 1	
Lake	Site Location Fecal Coliform Coun
Big Hill Lake	swim beach 1600/80*
Centralia Lake	swim beach 5/5
Clark Co. SFL	boat ramp 5/5
Concannon SFL	boat ramp 40/5
Elk City Lake	swim beach 5/5
Fall River Lake	fish cleaning station 5/5+
Goodman SFL	boat ramp 5/5
Herington Reservoir	fish cleaning station 100/100
Jamestown WMA	open water 470/200
Jetmore Lake	swim beach 5/5
Jewell Co. SFL	boat ramp 5/5
Kirwin Lake	boat ramp 20/30
Lake Coldwater	swim beach 5/100
Lake Kahola	boat ramp 20/10
Lake Meade SP	swim beach 5/5
Lake Scott SP	swim beach 10/40
Lake Shawnee	boat beach area 5/5
Lovewell Lake	courtesy dock 100/200+
Mined Land Lake 6	boat ramp 5/5
Mined land lake 7	boat ramp 5/10
Mined Land Lake 17	boat ramp 5/5
Mined Land Lake 44	boat ramp 80/50
Moss Lake (central)	shoreline area 500/200
Moss Lake (west)	shoreline area 100/200
Norton Lake	dam face 200/100+
Otis Creek Lake	dam face 100/5
Ottawa Co. SFL	boat ramp 5/5
Rooks Co. SFL	boat ramp 20/200
Toronto Lake	swim beach 5/5
Waconda Lake	swim beach 60/100
Washington Co. SFL	courtesy dock 5/10

^{* =} The duplicate samples are very dissimilar, yet Big Hill Lake has been a concern for high bacterial counts at the swimming beach in the past. The possible cause of past problems has never been sufficiently determined.

+ = These lakes have swimming areas, but at the time of their surveys these swimming beaches were not available for sampling due to previous high water which left the area unusable to the public.

Table 8. Limiting factor determinations for the 31 surveyed lakes in 1995, including TN/TP ratios. Factors are listed in descending order of importance.

Lake	TN/TP Rati	o Li	miting Factor	s Present
Big Hill Lake	37.2		Phospho	orus
Centralia Lake	27.8		Phospho	
Clark Co. SFL	22.5		Phospho	orus
Concannon SFL	5 5 5 5 5 7 . 7		Nitroge	en
Elk City Lake	13.3	116	Phosphorus,	
Fall River Lake	13.3		Phosphorus,	Light
Goodman SFL	61.0		Phospho	orus
Herington Reservoir	13.0		Phosphorus,	Light
Jamestown WMA	7.3		Nitroge	en –
Jetmore Lake	157.8		Phospho	orus
Jewell Co. SFL	155.0		Phospho	orus
Kirwin Lake	19.6		Phospho	orus
Lake Coldwater	11.8		Phosphorus,	Nitrogen
Lake Kahola	>200.0		Phospho	orus
Lake Meade SP	21.2	E (3)	Phospho	orus
Lake Scott SP	22.3		Phospho	orus
Lake Shawnee	9.8		Phosphorus,	Nitrogen
Lovewell Lake	31.4		Phospho	orus
Mined Land Lake 6	39.5		Phospho	orus
Mined Land Lake 7	36.4		Phospho	orus
Mined Land Lake 17	45.5	5 - T - 1 - 1 - 1	Phospho	orus
Mined Land Lake 44	49.8		Phospho	rus
Moss Lake (central)	52.9		Phospho	orus
Moss Lake (west)	>85.0		Phospho	orus
Norton Lake	16.2		Phospho	orus
Otis Creek Lake	24.0		Phospho	rus
Ottawa Co. SFL	11.9		Phosphorus,	Nitrogen
Rooks Co. SFL	17.3		Phospho	orus
Toronto Lake	16.6		Phosphorus,	Light
Waconda Lake	20.6		Phospho	
Washington Co. SFL	19.0	1 E 2 2 2 E	Phosphorus,	Light

that no unobserved circumstances or conditions, present at the time of sampling, influenced which nutrient or factor became the limiting one.

As can be seen from the data in Table 8, phosphorus is the primary limiting factor for lakes surveyed during the summer of 1995. Twenty-six of the 31 lakes were primarily phosphorus limited, or limited by both phosphorus and light availability. Two lakes were limited primarily by nitrogen. Three lakes were identified as likely limited by both phosphorus and nitrogen.

Surface Water Exceedences of State Water Quality Criteria

All numeric water quality criteria referred to in this section are taken from Chapter 28 of the Kansas Administrative Regulations (K.A.R. 28-16-28b through K.A.R. 28-16-28f), or from EPA water quality criteria guidance documents (EPA 1972, 1976; KDHE, 1994). Copies of the Standards may be obtained from the Office of Science and Support, KDHE, Building 283, Forbes Field, Topeka, Kansas 66620.

Tables 9 and 10 present documented exceedences of state surface water quality criteria during the 1995 sampling season. These data were generated by comparison of a computer data retrieval, for 1995 Lake and Wetland Monitoring Program ambient data, to the state surface water quality standards. Only those samples above 3.0 meters depth were used to document standards violations, as a majority of those samples below 3.0 meters are from hypolimnetic waters. In Kansas, lake hypolimnions generally constitute a small percentage of total lake volume and, while usually having a greater number of pollutants present in measurable quantities (compared to surface waters), do not pose a significant water quality problem for the lake as a whole.

With respect to the aquatic life support use, low dissolved oxygen and high pH constituted the majority of the exceedances of numeric water quality criteria during 1995. Out of 20 lakes and wetlands with exceedences, eight exceeded the chronic criterion for dissolved oxygen and nine exceeded the high pH criterion. Next, in terms of frequency, were violations of several heavy metal chronic criteria plus the chronic criterion for atrazine. All pH exceedences were for values above 8.5 standard pH units. In all cases, these high values were due to primary production within the algae and macrophyte communities, not due to outside pollution sources. Likewise, all low dissolved oxygen values were due to the shallow stratification of a few of the surveyed lakes. These shallow stratification situations were due to the existing, site specific, weather conditions during the early summer. They do not represent the effects of outside pollution sources.

As shown in Table 10, there were relatively few exceedences of surface water quality numeric criteria (not including aquatic life support) during 1995. Only three of the drinking water quality criteria exceedences occurred in waterbodies that currently host that use. Likewise, only two of the agricultural use exceedences occurred where irrigation or livestock watering presently exists. Most of the "human use" criteria exceedences were for the human health use, which is reflective of ambient water quality conditions believed to prevent risks associated with the consumption of harvested aquatic life.

Table 9. Chemical parameters exceeding chronic and acute aquatic life support criteria in lakes surveyed during 1995. Chemical symbols are from the Periodic Table of the Elements. Atz = atrazine while TSS = total suspended solids. Aquatic life support = ALS while dissolved oxygen = DO. Only those lakes with some type of documented exceedence are included in Tables 9 and 10.

	Chronic ALS						Acute ALS						
Lake	Cl	Se	Ве	Hg	DO	рH	Atz	Th	Sb	TSS	The s	Sb	1 IV 90 601
Centralia Lake			121	5 1 3	1	x	×	4			22 🖂	4	
Clark Co. Lake	9 , 1			46		\mathbf{x}					vil 1		
Concannon SFL	185			x		X	1.00						
Fall River Lake	3 1/-				x			x			1		2.1
Goodman SFL	19.1				×	1					17		
Herington Reservoir	j -	14			x		×						
Jamestown WMA	1777 X		1157.6			x	x		\mathbf{x}	x	120		4 4
Jetmore Lake	1.50					x					a 8		403
Jewell Co. SFL	· 1		x	x							Angle:		
Lake Coldwater						x					8 2 6		
Lake Kahola									x			×	
Lake Meade SP	2.5				X	x					M = 3	4	lises.
Lake Scott SP	9					X					1		500
Mined Land Lake #44				X							1 2		
Mined Land Lake #6					x						. 41	11.	10
Ottawa Co. SFL				1	×					1	a fil		0
Rooks Co. SFL	x	X				7.5					4.0		25
Toronto Lake	=				X			2			· .		7
Waconda Lake	8,0					X					. 111		
Washington Co. SFL					x							7	17.5

The human health use category refers to ambient water quality considered protective for human consumption of aquatic life. Only lakes with documented exceedences are included within the table. An "x" indicates that the exceedence occurred for a Exceedences of human use criteria and/or EPA guidelines within the surface waters Atz = atrazine, SO4 = sulphate, and TDS = total dissolved solids. An "*" indicates that the exceedence occurred where the indicated use does not of the lakes surveyed during 1995. Symbols are taken from the Periodic Table of use presently existing, or likely in the foreseeable future, at the given lake. presently exist. the Elements. Table 10.

Lake	Water Supply Atz F Cl Sb Th Be TDS SO4	Irrigation 74 TDS B F	Human Health Hg Be Th	Human Health Livestock Water Hg Be Th SO4 F
Centralia Lake	*			1.00
Concannon SFL	*	*	*	
Fall River Lake	×	7	×	
Jamestown WMA	*	*		
Jewell Co. SFL	*		×	3 11
Lake Kahola	×			
Lake Scott SP		*		
Mined Land Lake #17	*	*		*
Mined Land Lake #44	*	*	×	
Mined Land Lake #6	*	*		32
Mined Land lake #7	*	*		*
Moss Lake West	*	* * *		*
Rooks Co. SFL	*	*		*
Waconda Lake	×	×		

Pesticides in Kansas Lakes, 1995

Fourteen lakes had detectable levels of pesticides within the main body of the lake during 1995. Table 11 lists these lakes and the pesticides that were detected, along with the level detected and analytical quantification limit. Four different pesticides were detected in total.

Atrazine continues to be the most often detected pesticide in lakes in Kansas (KDHE, 1991). Atrazine was identified in all fourteen lakes with detectable levels of pesticides. Three lakes had detections of Dual (metolachlor), one lake had a detection of alachlor, and one lake had a detection of simazine during 1995.

In all cases, the detection of these pesticides indicates impacts from agricultural nonpoint source pollution, although the simazine detection in Lake Shawnee may be indicative of urban weed control, or golf course turf maintenance, to some degree. The sites of most concern during 1995 were Centralia Lake, Herington Reservoir, and Jamestown WMA. These three sites exceeded the chronic aquatic life support criterion for atrazine, while one would have exceeded the drinking water maximum contaminant level for atrazine.

Discussion of Nonpoint Sources of Pollution for Selected Lakes

Certain lakes and wetlands were chosen for further discussion, based on the number and type of surface water quality standards exceedences that were observed. A waterbody was chosen if 1) three, or more, parameters experienced exceedences of chronic criteria of the aquatic life support use, 2) more than one parameter experienced exceedences of acute criteria of the aquatic life support use, or 3) more than one parameter exceeded irrigation, water supply, livestock watering, or human health criteria.

Based on these considerations, ten lakes and wetlands were chosen for further discussion regarding the number and sources of their use impairments. The ten waterbodies identified were Concannon SFL, Fall River Lake, Jamestown WMA, Jewell Co. SFL, the western Moss Lake, Rooks Co. SFL, and the four Mined Land Lakes.

In the case of the four Mined Land Lakes, criteria exceedences revolve around salinity. This is due to past mining activity that was responsible for creating these lakes. Only in Mined Land Lake #44 was there a non-salinity related impairment. This concerned mercury detection under the human health use. As for many other midwestern states, mercury is often the result of atmospheric deposition.

In the cases of Jamestown WMA, Concannon SFL, Rooks Co. SFL, and the western Moss Lake, exceedences of uses are mainly salinity

Table 11. Pesticides detected during 1995 in Kansas lakes. All values are in ug/L. Analytical quantification limits are as follows for the four detected pesticides: atrazine = 0.3 ug/L, metolachlor (Dual) = 0.25 ug/L, alachlor = 0.1 ug/L, and simazine = 0.3 ug/L. The "exceeded" column refers to whether atrazine concentrations exceeded current chronic aquatic life support (ALS) levels (1.0 ug/L), or the current MCL of 3.0 ug/L for water supply (WS).

1 - 4 - 4 - 4	Exceeded				
Atrazine	Dual	Alachlor	Simazine	ALS	WS
0.91 5.50 0.46 0.58 0.68	1.80	0.55		xxxx	xxx
1.60	0.47	5 EN		XXXX	4
0.68	0.99	47	nge 3 n	****	=×_ =
0.31	100		2.00	* 5 = 2	1.
0.47 0.33		ing the grant of	14 C = 1		4
0.71	TET A Bu	n validad an facilit	1 - 11 - 1		
	0.91 5.50 0.46 0.58 0.68 1.60 1.40 0.68 0.31 0.68 0.47 0.33	Atrazine Dual 0.91 5.50 0.46 0.58 0.68 1.60 1.40 0.68 0.31 0.68 0.47 0.33 0.71	0.91 5.50 0.46 0.58 0.68 1.60 1.40 0.47 0.68 0.47 0.68 0.47 0.33 0.71	Atrazine Dual Alachlor Simazine 0.91 5.50 0.46 0.58 0.68 1.60 1.40 0.68 0.31 0.68 0.47 0.33 0.71	Atrazine Dual Alachlor Simazine ALS 0.91 5.50 0.46 0.58 0.68 1.60 1.40 0.68 0.31 0.68 0.47 0.33 0.71

related. The salinity problems in these waterbodies can be related to natural geologic inputs, although irrigation return flows and/or evaporative concentration may also influence them. The antimony detected in Jamestown WMA, and the fluoride and boron detections in Moss Lake West, can also be considered a natural geologic problem.

Criteria exceedences in the remaining two lakes (Fall River Lake and Jewell Co. SFL) revolve around heavy metal detections that exceed human health and drinking water supply criteria. Given the small amounts of urban drainage in these two watersheds, the heavy metal detections are likely due to natural surface geology.

Taste and Odor/Algae Bloom Investigations and Other Special Investigations in 1995

During the period of October 1, 1994 to October 31, 1995, six investigations were undertaken within the auspices of the Taste and Odor/Algae Bloom Program. Each will be discussed individually within the remainder of this section. Four of the investigations

were related to fishkills while the other two were related to aesthetic complaints, or potential algal toxicity.

On June 15, 1995, algae samples were submitted by staff from the Northeast District Office from Miami County State Fishing Lake. It was indicated that there had been a fishkill, mostly involving shad, at the lake. Samples contained between 240,000 and 1,100,000 cells/mL of the blue-green algae Anabaena spiroides. While this blue-green algae is known to be a toxin producer, low dissolved oxygen and high ammonia levels were more likely the primary cause of the fishkill. Ammonia ranged in concentration from 0.11 to 1.27 mg/L at the surface, and was likely the result of algae decomposition. With such a large bloom, early morning low dissolved oxygen is also very common.

On June 19, 1995, algae samples were submitted by staff from the Northeast Kansas District Office from the Melvin Frickey Pond at Hoyt, Kansas. The samples were submitted as part of a complaint about the aesthetic condition of the pond. The pond was reported as having a terrible odor and yellow mats of algae on the surface. The pond water was also stained with a purple-black substance. Examination of the samples revealed the blue-green algae Lyngbya This blue-green algae forms exceptionally tough mats on the bottom of lakes and ponds, which can then pull free during periods of photosynthesis or decomposition. These mats do not readily decompose, turn yellow-orange in direct sunlight, produce a distinctive purple-black dye, and can produce very unpleasant Lyngbya wollei has become a considerable pest species in standing freshwater environments along the eastern coast of the United States in recent years. It is reported to be spreading into the Midwest (NALMS, 1994). It is likely that this algae will be reported in the future in Kansas lakes and ponds.

On July 6, 1995, algae samples were collected by staff from the Southcentral District Office as part of a fishkill investigation from a small private pond in Wichita, Kansas. Examination of the sample revealed the presence of the blue-green algae Oscillatoria spp., in the approximate amount of 56,000 cells/mL. While there are indications within the literature that this type of blue-green algae can produce toxins, it was suggested that low dissolved oxygen, during the early morning hours, was the more likely primary cause of the fishkill.

On July 28, 1995, algae samples were submitted by staff from the Southcentral District Office from a fishkill investigation at the Alexander Pond, in Sedgwick County. The algae samples contained blue-green algae, Anabaena sp., in the amount of 200,000 to 300,000 cells/mL. Also present within these samples were abundant filamentous green algae, Spirogyra sp., and abundant debris from decaying coontail plants (Ceratophyllum demersum). The pond had also been reported as having a "tea-like" coloration. It was concluded that the die-off of such abundant vegetation, in a pond

less than one acre in size, would explain both the coloration of the water and the occurrence of a fishkill, due to decomposition and low night-time dissolved oxygen.

On September 5, 1995, algae samples were submitted by staff from the Southcentral District Office from an investigation of a small city-owned pond within Wichita. The pond, which serves as a stormwater catchment basin, was reported as having a noticeable oily "sheen" which was of some concern. Examination of the samples revealed an abundant filamentous algae community, composed mainly of the green algae Spirogyra spp. Also present was evidence of the macrophytic plant Najas guadalupensis (water naiad). It was indicated that stagnant conditions, in such a productive environment, could produce oily surface films. Given that the pond is used to catch and treat storm runoff from city streets, the possibility existed that the oily sheen was due to urban nonpoint pollution. However, citizens fishing at the time of the investigation indicated that the oily surface film was very subtle, and not very prominent.

On October 17, 1995, water samples were collected by staff from the Northcentral District Office as part of a fishkill/disease investigation at Kanopolis Lake, in Ellsworth County, Kansas. was reported by staff from the Kansas Department of Wildlife and Parks that fish of several different species and age groups exhibited some evidence of disease. The algae community identified in Kanopolis Lake was small (2,000 to 4,000 cells/mL) and composed of a mixture of green flagellates and diatoms. Chemical samples collected at the same location indicated a dissolved oxygen concentration of 10.0 mg/L, but a biochemical oxygen demand (BOD) of 6.6 mg/L. While the dissolved oxygen level could be considered high and satisfactory for fish, any BOD value above 2.0-to-3.0 mg/L is also very high for a lake environment and may be indicative of organic loading (possibly from a sewage by-pass from the City of Ellsworth that had taken place in the recent past). Local weather observations also suggested the possibility of thermal stress during the two months previous to the observations of the diseased fish.

As of summer 1996, the investigation into the fishery problems at Kanopolis Lake continues, as does the incidence of fish disease. BOD data collected during the last year have ranged from less than 1.5 mg/L to greater than 18.0 mg/L, with the higher BOD values appearing to be related to high inflows and increases in lake level.

CONCLUSIONS

The following conclusions are offered, based upon the lake monitoring data obtained during 1995.

- 1. Trophic state conditions suggested that most lakes surveyed in 1995 were stable (about 38%) or degrading (about 40%), in terms of past trophic state compared to current condition. The remaining 22% displayed some improvement in trophic status compared to their last survey. This is consistent with past years of survey data.
- 2. Exceedences of surface water quality criteria revolved primarily around two parameter groups. These were salinity (exceedences of drinking water supply and irrigation criteria) and in-lake processes (exceedences of aquatic life support criteria related to high pH and low dissolved oxygen). Pesticide and heavy metal related use impairments were fewer than observed in past years. This likely reflects the individual lakes surveyed during 1995, rather than any changes in land use or the level of pollution production in Kansas watersheds generally.
- 3. Fourteen of the 31 surveyed lakes (45% of the total) had detectable concentrations of agricultural pesticides during the summer of 1995. Atrazine was the most commonly encountered pesticide. Roughly ten percent of lakes surveyed in 1995 exceeded the chronic aquatic life support criterion for atrazine.

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LAKE DATA AVAILABILITY

Lake data are available for all lakes included in the Kansas Lake and Wetland Monitoring Program. Water quality data may be requested by writing to the Office of Science and Support, KDHE, Building 283, Forbes Field, Topeka, Kansas 66620-0001. All data referenced within this report are also accessible on STORET.